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HAZARD RATING AND MANAGEMENT OF ANNOSUS ROOT ROT ON THE BANKHEAD NATIONAL FOREST

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ABSTRACT

Annosus root rot is the primary cause of post-thinning mortality in several areas of the Bankhead National Forest. Based on data from a field evaluation of thinned stands on different soil types, a hazard rating is mapped. Hartsells, Nauvoo, Pirum, Savannah, Smithdale, and Wynnville soils are identified as high hazard for annosus root rot. Management alternatives for prevention or control of annosus root rot are presented, including: stump treatment, pre- and post-thinning prescribed burning, and species manipulation.

INTRODUCTION

Annosus root rot has been diagnosed as the primary cause of post-thinning mortality in several pine stands on the Bankhead National Forest (Mistretta and Starkey, 1982). This report identifies soil series on the Bankhead National Forest which cause high, mixed, or low hazard for this disease. Biological and edaphic information is presented to allow foresters to hazard rate a site, and to recommend effective prevention or control measures.

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Annosus root rot is a disease of southern yellow pines caused by the fungus Heterobasidion (Fomes) annosum (Fr.) Bref. As its common name implies, this disease results in the degradation of the root systems of infected trees. The root rot that it causes is a stringy white rot; all woody components, including lignin, are decayed. The result of this decay is a root whose structure has been degraded to the point that it no longer functions to conduct water and nutrients or to support the tree.

Annosus root rot is reported to be most severe in thinned pine plantations established on sites with a high sand content in the soil. Natural stands of pine are not as severely affected by this disease as are planted stands.

Biology of the Disease

Spores (functional equivalents of seeds) of this fungus are produced in a distinctive conk (fruiting body). These conks (fig. 1) are normally formed at or about the level of the duff at the base of infected trees or stumps. Spores are airborne and common in areas where the fungus is present.

Spores are deposited on freshly cut stump surfaces. They germinate and the fungus grows throughout the stump and into its root system. Where colonized roots contact or graft with the roots of a live tree, the fungus spreads. As the fungus progressively decays the root system of the tree, the root's ability to transport liquids and nutrients is eroded.

Root systems affected by annosus root rot are readily diagnosed. In the early stages of this disease, roots become pinker than normal and generally show resin soaking (fig. 2). In the intermediate stage of the disease, rot appears as white pockets of decay. Later, as these pockets join together, the roots take on the white, stringy appearance characteristic of this disease (fig. 3).

Crown symptoms begin to appear when nutrients or liquids become limiting to normal growth. Crown symptoms begin as a thinning of the foliage. Less often a yellowing to browning of the remaining needles occurs. Crown decline is progressive, generally resulting in tree death. Root-sprung or wind-thrown trees are commonly seen where this disease is active; top-heavy trees without sufficient numbers of sound roots simply fall over (fig. 4). Any combination of these symptoms can occur in a stand. Dead or declining trees often occur in pockets or centers formed when the disease spreads outward from tree to tree. Pockets can be large and distinct, or they can be small and scattered throughout the stand (giving the appearance of uniform distribution.)

Conks form on stumps or at the base of dying or dead trees. They are often formed below the litter, and, in the South, are most common during the winter months. Sometimes conks are formed on the roots of rootsprung trees.

Southern yellow pines are all susceptible to this disease, however, longleaf pine appears to be somewhat resistant. Loblolly, slash, and shortleaf pines are prime suscepts.

Losses are experienced directly through mortality, however, the undetermined loss of growth by infected trees may be causing a greater loss (Alexander, Skelley, & Webb, 1981). The latter is a persistent problem throughout the life of the stand.

Soils and Hazard Rating for Annosus Root Rot

A correlation exists between the soil found on a site and the amount of infection and damage to trees susceptible to annosus root rot. Well-drained, deep, sand or sandy-loam soils present the most serious hazard. Deep sandy or sandy-loam soils are described as soils with 12 - 24 or more inches of sand or sandy-loam soil at the surface before reaching any significant clay inclusion.

Based on this definition, a preliminary classification of annosus root rot hazard can be made of soils on a site or on an entire forest. Initial classification is made as low hazard (soils description shows significant clay in the top 12 inches of the series), or as probable high hazard. Field evaluation of this rating is then made and the results summarized and generalized for the larger area being evaluated.

Hazard rating has absolutely nothing to do with soil fertility. Both very productive and very poor sites can be rated high hazard for annosus root rot. From a silvicultural point of view, recognizing a site as having high hazard for annosus rot rot does not eliminate the site from productivity! However, special consideration must be given to the potential for serious disease problems on this site. Several alternatives for prevention or control are outlined later in this paper. These alternatives need to be evaluated in a site specific manner by a qualified prescriptionist and a silviculturist before the final prescription is written for a stand on a high hazard site. Valid reasons may exist for rejecting any or all of these choices, but when prescribing for a high hazard site they should be considered.

"High hazard" has not yet been experimentally quantified. No formulae exist which project volume loss for stands infected with annosus root rot. Loss of volume as a result of reduced growth is currently being investigated. Lacking empirical data, "high hazard sites" are those sites on which we expect a significant amount of infection and damage to the residual stand from annosus root rot after thinning if no preventative strategy is employed.

MATERIALS AND METHODS

Blueprints of order 3 soils maps (7.5 minute quadrangle maps) prepared by the Soils Conservation Service for the entire Bankhead National Forest were used to prepare mylar overlays; soils boundaries, major roads, and Forest boundaries were transferred to these sheets.

During the initial phase of the field work we identified sites that had been thinned three to ten years ago. A sample of these sites were evaluated in the field.

Observations were made at each site as to soil type (mapped series and actual physical characteristics); time since thinning; annosus root rot activity (decline or mortality in the stand, conks, and stringy roots were all noted); and stand type. Using conclusions drawn from these data, the mylar overlays were colored to reflect hazard.

RESULTS

A map is presented (fig. 5) showing the locations of the 18 sites ground checked on the Bankhead National Forest.

Four of the five sites visited on Smithdale soil showed evidence of extensive root rot activity by H. annosum (sites A, I, M, & R). Trees on the fifth (site B) showed serious brown cubical root and butt rot consistent with, but not confirmed as, the activity of either Phaeolus (Polyporus) schweinitzii (Fr.) Pat. or Inonotus (Polyporus) tomentosus (Fr.) Gilbn. Extensive post-thinning damage to the residual stands was present on all of these sites. Smithdale soil is high hazard for annosus root rot on the Bankhead National Forest.

Three sites were visited on Hartsells soil (D, G, and K). All showed the effects of annosus root rot activity. On site G we estimated that up to 50% of the residual stand has been lost to this disease since thinning. Hartsells soil is high hazard for annosus root rot.

Three sites were evaluated on Wynnville soil (J, L, and N). Sites J and L are breaking up due to annosus root rot activity. Evidence of southern pine beetle activity was seen on all three of these sites. On site N we were unable to locate signs of annosus root rot. Several of the trees were showing early symptoms of the disease, but no conks or stringy roots were seen to confirm the cause of the problem. Based on the two sites showing serious annosus root rot damage and the unconfirmed strong suspicions that the third stand was also suffering from annous root rot, we classed Wynnville soil as high hazard.

Some confusion exists with codes 44 and 47 on the soils maps. Forty-four is listed as either Wynnville or Savannah soil depending on which key is used. Savannah is a very similar soil to the Wynnville series (47 on

one code sheet, 44 on another) and conclusions drawn for Wynnville have been applied to Savannah; it is a high hazard soil.

Three sites were seen on Nauvoo soil (C, F, and H). Limited fruiting of H. annosum was seen, but stringy roots were common on all three sites. Nauvoo is classed as a high hazard soil.

The single site seen on Pirum soil (E) had been thinned recently. This stand is already breaking up. While only a single H. annosum conk was found on this site, stringy roots were extremely common. Pirum is classified as high hazard.

Three sites were visited which had been projected as low hazard (P, Q, and S). Sites P and S are located on the Apison/Townley complex while Q was located on the Remlap/Townley/Talbott complex. Despite substantial thinning activity none of these three sites showed any annosus root rotting activity; neither decline, mortality, conks, nor stringy roots were seen on these sites.

Based on the above information the following generalizations have been made for the Bankhead National Forest. High hazard soil series for annosus root rot activity include Hartsells, Nauvoo, Pirum, Savannah, Smithdale, and Wynnville. Low hazard soil series include Apison, Mooreville, Remlap, Talbott, Tidings, and Townley. Two soil types (Hartsells and Pirum) are found in mixture with other series throughout the Forest. Areas of mixed soils series are to be taken as having a hazard rating based on the proportion of the high versus low hazard soil in the area. Two soils (Spadra and Ochlochonee) have extremely limited distribution (two small pockets on the Poplar Springs quadrangle map) and were not evaluated.

Following this field evaluation the mylar maps were color coded; red for high hazard, green for low hazard, and yellow for those areas where mixed soils cause a mixed hazard (figs. 6-22).

The maps which have been prepared are extremely conservative. They reflect only soils series information and do not consider hydrological input, slope, or logical silvicultural type for the area. Some of the areas which have been classified as high hazard may actually have a lower hazard as a result of water relationships (e.g., much of the pure Pirum series [map code 84] appears in stream bottoms which will probably cause them to be wetter than the normal high hazard site). Also, silvicultural considerations will dictate that much of the area marked as high or mixed hazard will never support a pine plantation.

As will be readily appreciated from the hazard maps, Pirum and Hartsells complexes account for the major part of the land mass of the Forest. On-site evaluation is the only way to determine the annosus root rot hazard for a given stand on these complexed soils.

As a general rule of thumb, if 50% or more of the stand being evaluated is on a high hazard soil, the prescriptionist should further evaluate preventive or control measures for annosus root rot. A more conservative rule would suggest that prevention/control be practiced if there is any high hazard soil on the site.

One relationship that we noted is the presence of southern pine beetles on sites where annosus root rot was active. Fully half of the sites where annosus root rot was active also showed signs of southern pine beetles. This relationship has been reported (Alexander et al., 1980), and field observations in this Forest further support this relationship. It is felt that annosus weakened trees are the first trees attacked by the beetles. While favoring these weakened trees for their initial attack, if sufficient population buildup occurs, the beetles will spread to healthy neighboring trees.

PREVENTION AND CONTROL STRATEGIES

Thinning presents the greatest danger of introducing or spreading this disease in a stand. The presciptionist should recognize this as the best opportunity to prevent entry of the disease into the stand. Several methods are available for preventing or controlling annosus root rot in the forest. Choice of a specific strategy is based on silvicultural, pathological, and economic considerations. Prescriptionists need to tailor the available strategies to fit the site requirements to maximize the benefit at each site.

Where disease hazard is low, as a result of site or stand characteristics, no prevention or control measures need to be taken. The recommendation is that they be managed without considering disease management strategies.

For high hazard sites supporting stands not currently infected with annousus root rot, prevention strategies useful on the Bankhead National Forest include: 1) thinning and treating freshly cut stump surfaces with powdered borax; 2) selectively thinning to favor less susceptible species (longleaf pine or hardwoods); 3) eliminating thinning in pulpwood rotations; 4) clearcutting at rotation or prior to prescription date, and regenerating with a less susceptible species, or mix of species; 5) manipulating planting density.

If annosus root rot is already present, reduction of further spread is accomplished by: 6) applying the biological control agent Phlebia (Peniophora) gigantea (Fr.) Donk to freshly cut stump surfaces.

In either high or low hazard situations: 7) prescribed burning within the six months preceding thinning and again soon after will also help to reduce infection.

These alternatives are explained more fully below.

1) Borax (in powdered form) prevents the fungus, H. annosum, from successfully colonizing the surface of the stump. This chemical can be easily sprinkled onto the stump by the sawyer or one of the logging crew. The entire protective operation rarely requires more than 15 seconds per stump to complete. A computer program is available through Forest Pest Management to evaluate cost versus benefit. We must emphasize that borax be used only on stumps of trees which have not been infected by annosus root rot. Borax prevents fungal entry through stump surfaces; use of it on the stump surface of an already infected tree prevents the entry of competitive fungi which may later serve to reduce infection by annosus root rot.

2) Selective thinning which favors non-susceptible species (including longleaf pine, hardwoods, and mixtures which can include a percentage of susceptible species distributed uniformly throughout the stand) should be encouraged.

3) Thinning is the time of greatest danger for the introduction of annosus root rot into a stand. If a pulpwood rotation should be specified on a high hazard site, eliminating thinning from the prescription will remove this dangerous point in the stand history.

4) Clearcutting is a management option available in both infected and uninfected stands at any time. By removing all the trees of the stand the danger of infection from annosus will be minimal and no volume loss should be experienced. If clearcutting is selected as an option, consideration must be given to the composition of the subsequent stand. On high hazard sites the choices become more limiting than on low hazard sites.

It is known that there are many sites on the Bankhead National Forest which are capable of carrying longleaf pine through to sawtimber rotation. Use of these sites for longleaf should be encouraged. On other high hazard areas, longleaf pine may not be silviculturally appropriate. Use other species such as hardwoods or mixed stands. Mixed stands reduce the probability of damage from annosus root rot infection occurring at the time of thinning by increasing spacing between the susceptible trees within the stand to the point that root to root contacts are minimized. Selection and use of non-susceptible species should confer a degree of resistance to the subsequent stand. Depending on the species selected, species manipulation also reduces danger of infection following thinning at some future date.

5) If it is determined by the silviculturist that only a susceptible species is appropriate on the given site, planting density can be manipulated at the time of out-planting to reduce the number of thinnings required for good management of the stand. Manipulation of planting density is effective on sites which have previously supported either infected or non-infected stands. If susceptible species must be planted on high hazard sites which supported an infected stand, expect to lose about five percent of the seedlings within the first five years after outplanting.

6) If thinning is to be done on a high hazard site where annosus root rot is already present, further spread of the disease can be reduced through the use of a biological control agent. Phlebia gigantea is a fungus which competes with H. annosum. It grows rapidly and colonizes the stump precluding successful colonization of the stump by annosus root rot. Phlebia gigantea is applied to the stump surface as a suspension of spores of the fungus in water. The process, as with borax, is very quick.

7) Prescribed burning within the six months preceding thinning, and soon after, will reduce the amount of infection on any site. The availability of spores is reduced by burning up those conks present at the level of the litter in the stand. An obvious additional benefit of this procedure is the removal of the understory vegetation which very often makes a thinning operation difficult.

Because of the geographic location of the Bankhead National Forest, summer thinning is not recommended except in conjunction with the use of either borax or Phlebia. The recommendation to use summer thinning alone (a procedure which depends on summmer heat to inactivate spores landing on the freshly cut stump surface) is made for those forest stands in geographic areas south of 34° north latitude. The entire Bankhead National Forest is north of that line. Using summer thinning as a preventive measure on this Forest will probably result in spotty prevention.

SUMMARY

A complete hazard rating for annosus root rot has been made for the Bankhead National Forest based on a field evaluation of soil characteristics and the condition of thinned stands. Maps have been prepared showing areas of high, low, and mixed hazard for annosus root rot. The maps are based on soil series. On-site evaluation is needed to determine the predominant soil type in areas of mixed hazard.

Prevention and control measures are suggested for the Bankhead National Forest. These measures require that the prescriptionist determine the current status of the stand on the site with relation to annosus root rot. On high hazard sites where annosus is not present and a thinning operation is planned, stump treatment using borax should be considered. On high hazard sites where annosus is already present and thinning is planned, the use of the biological control agent P. gigantea should be considered. On all high hazard sites selective thinning to favor non-susceptible species ought to be considered. Prescribed fire during the six months preceding thinning, and soon after, is recommended for use on those sites where annosus is already present, and should be considered on all high hazard sites.

Where clearcutting and regeneration is being proposed for a site, species manipulation to favor non-susceptible species on high hazard sites should be considered.

On low hazard sites no control measures need to be taken to prevent subsequent infection. Where hazard of infection is low, the cost of preventive or control measures is economically unjustifible.

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Figure 1. Typical conks of H. annosum at the base of an infected tree. The duff has been partially removed to expose the conks, but the difficulty encountered in locating these conks should be obvious on the covered section. The white color on the upper surface of the low conks is from spores deposited from the conks above.

Figure 2. Early symptoms of annosus root rot include resin accumulation in the root (at right) and white dried resin on the outer bark.

Figure 3. Late symptoms of annosus root rot are a straw color and an extremely stringy appearance of the roots. Roots at this stage of decay readily separate under stress.

Figure 4. Small root-sprung tree showing stringy broken root ends typical of annosus root rotted tissue.

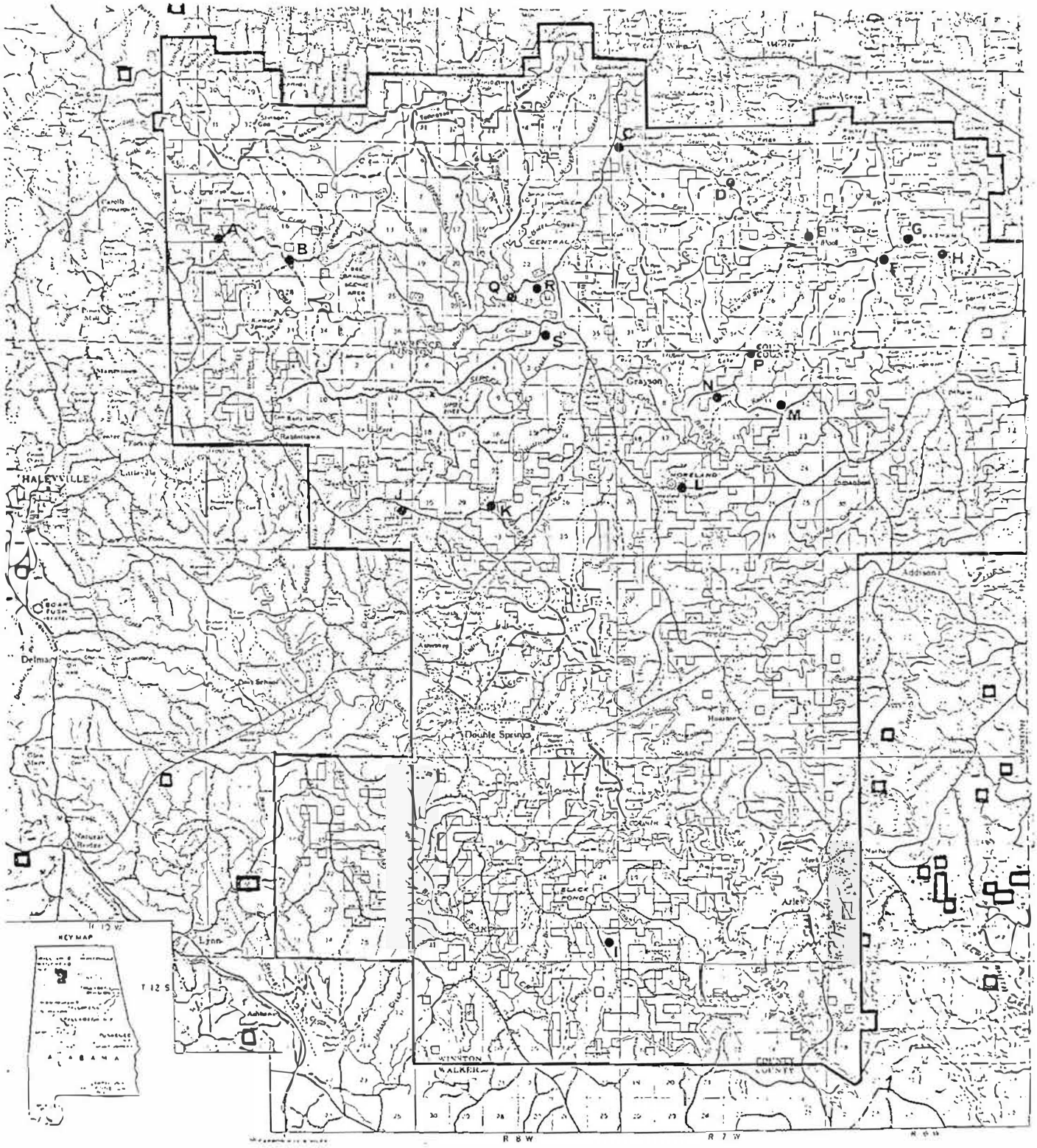

Figure 5. Map of the Bankhead National Forest showing the location of the sites which were evaluated for annosus root rot activity.

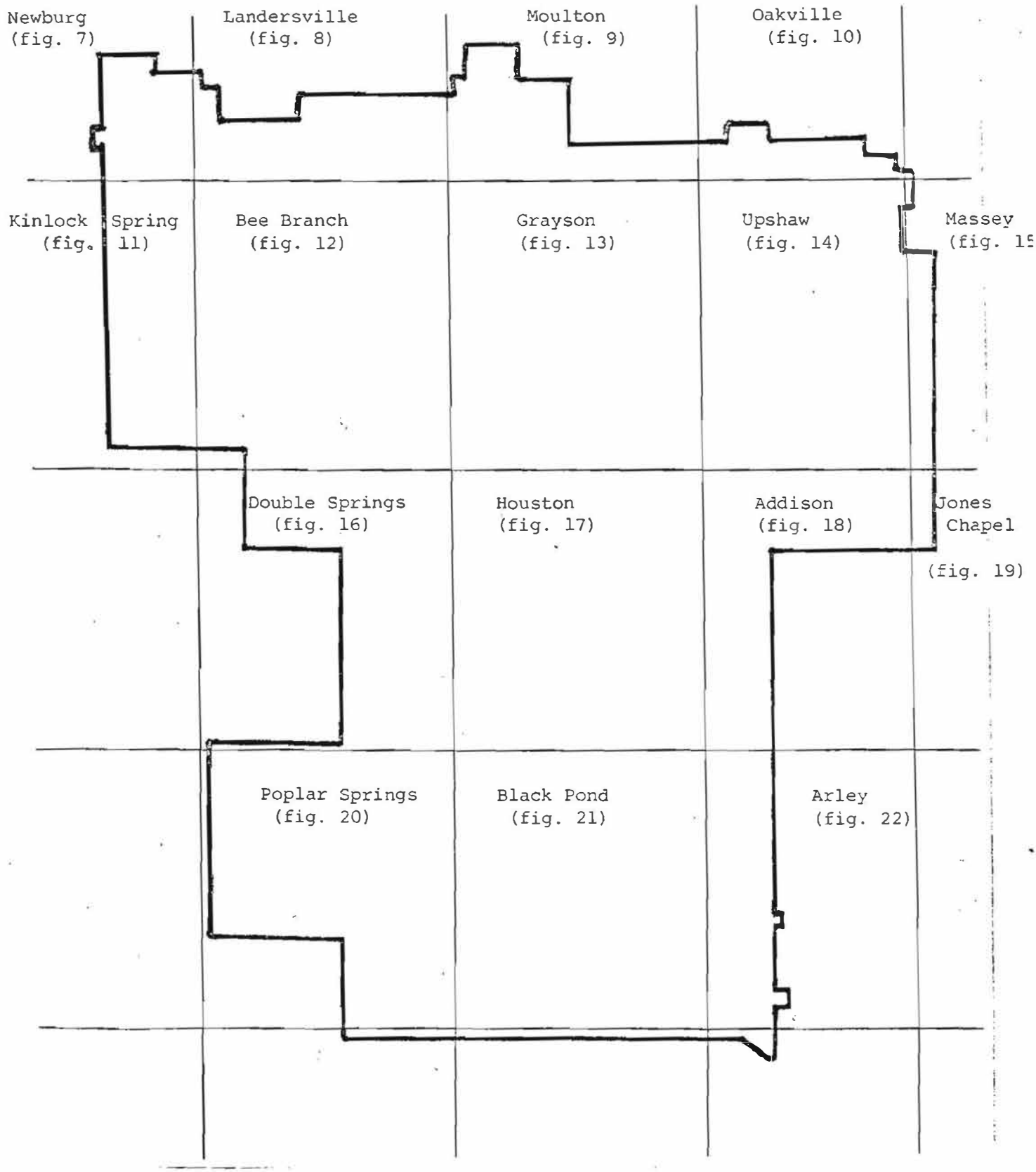

Figure 6. Key to locations of annosus root rot hazard rated maps (figures 7 to 22); names of quadrangles are U.S. Geological Survey names. Colors on maps are: pink = high hazard; yellow = mixed soil type and hazard; green = low hazard for annosus root rot; red lines = mapped roads (some are no longer usable).

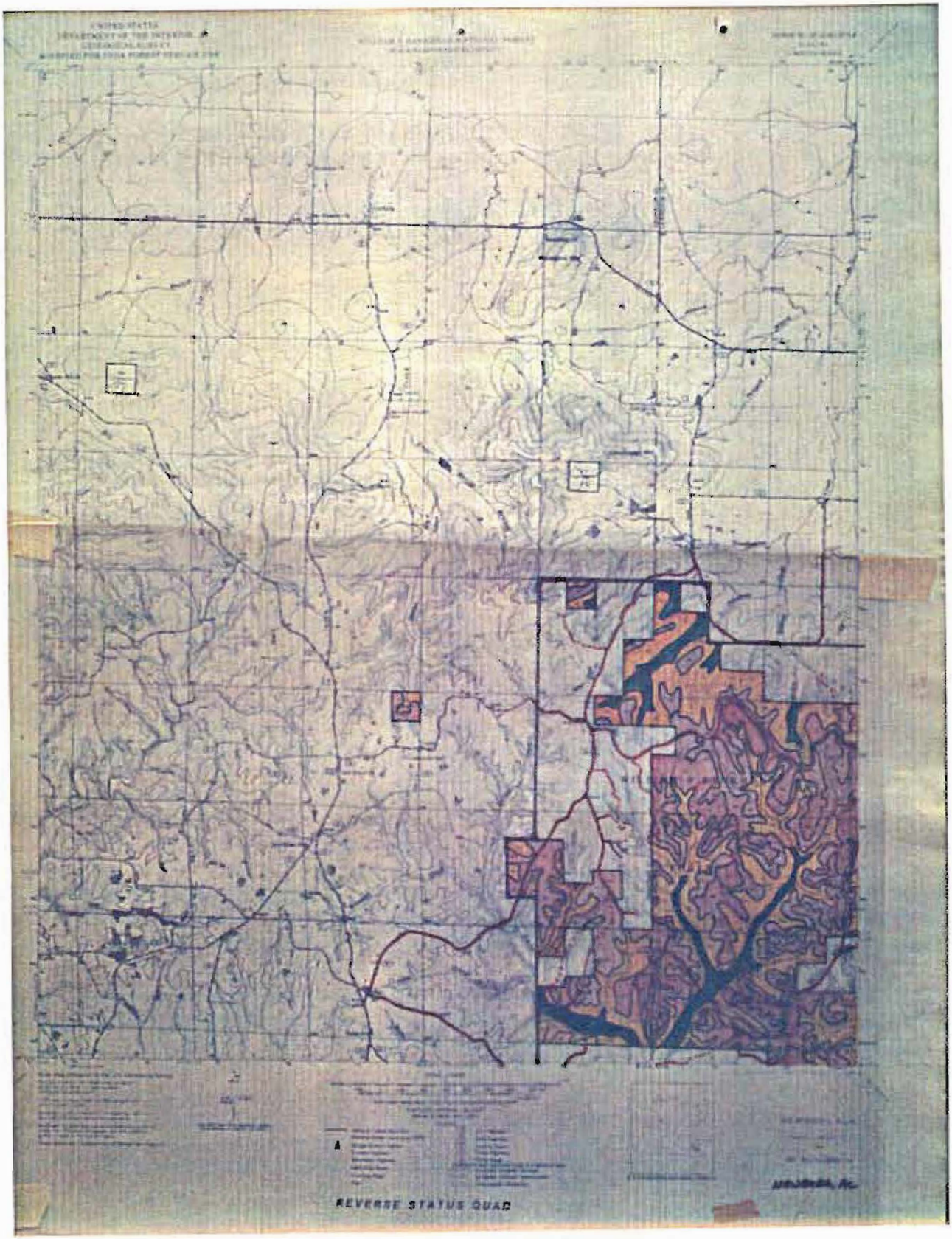

Figure 7. Annosus root rot hazard rating of Bankhead National Forest lands in the Newburg, Alabama, quadrangle.

Figure 8. Annosus root rot hazard rating of Bankhead National Forest lands in the Landersville, Alabama, quadrangle.

Figure 9. Annosus root rot hazard rating of Bankhead National Forest lands in the Moulton, Alabama, quadrangle.

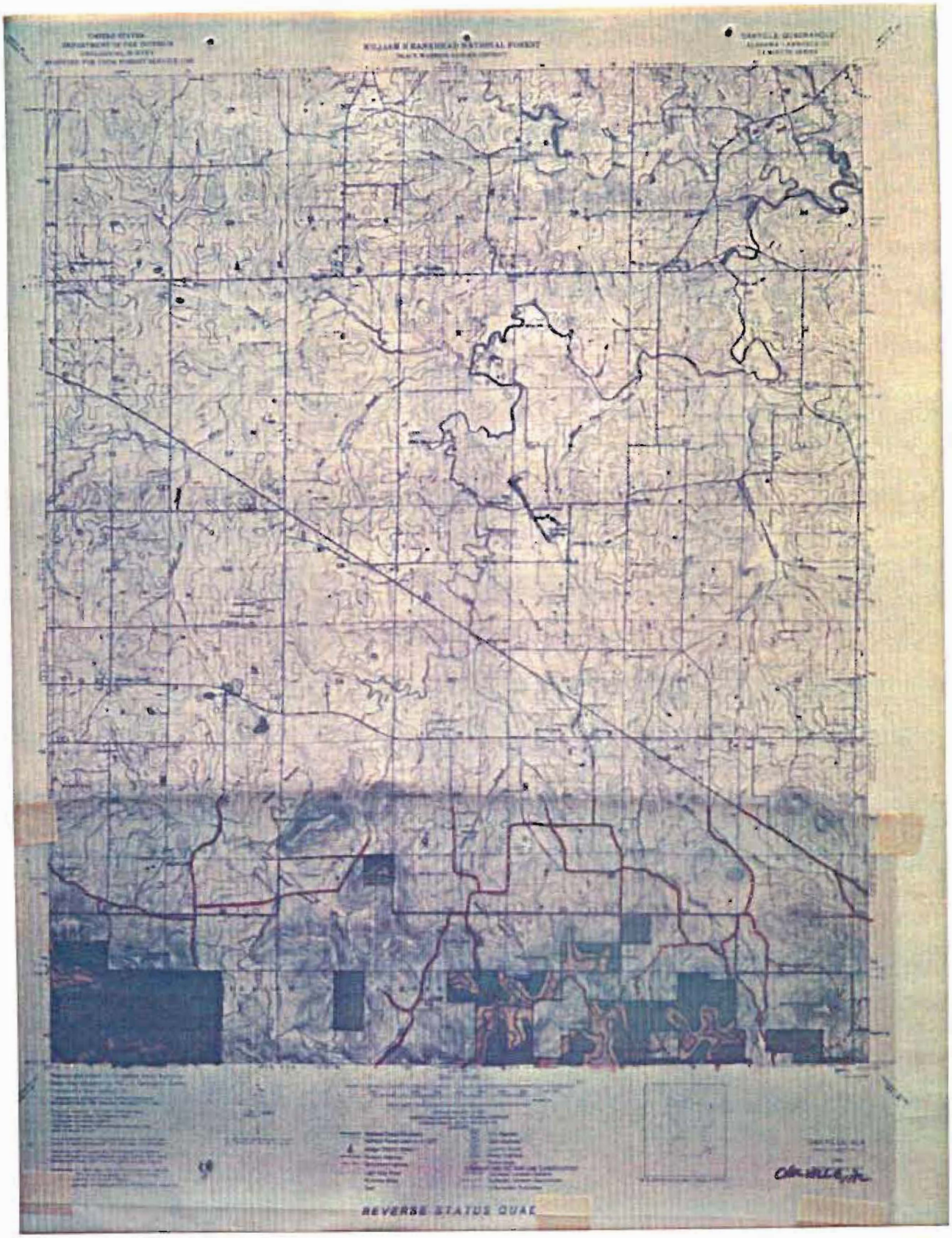

Figure 10. Annosus root rot hazard rating of Bankhead National Forest lands in the Oakville, Alabama, quadrangle.

Figure 11. Annosus root rot hazard rating of Bankhead National Forest lands in the Kinlock Spring, Alabama, quadrangle.

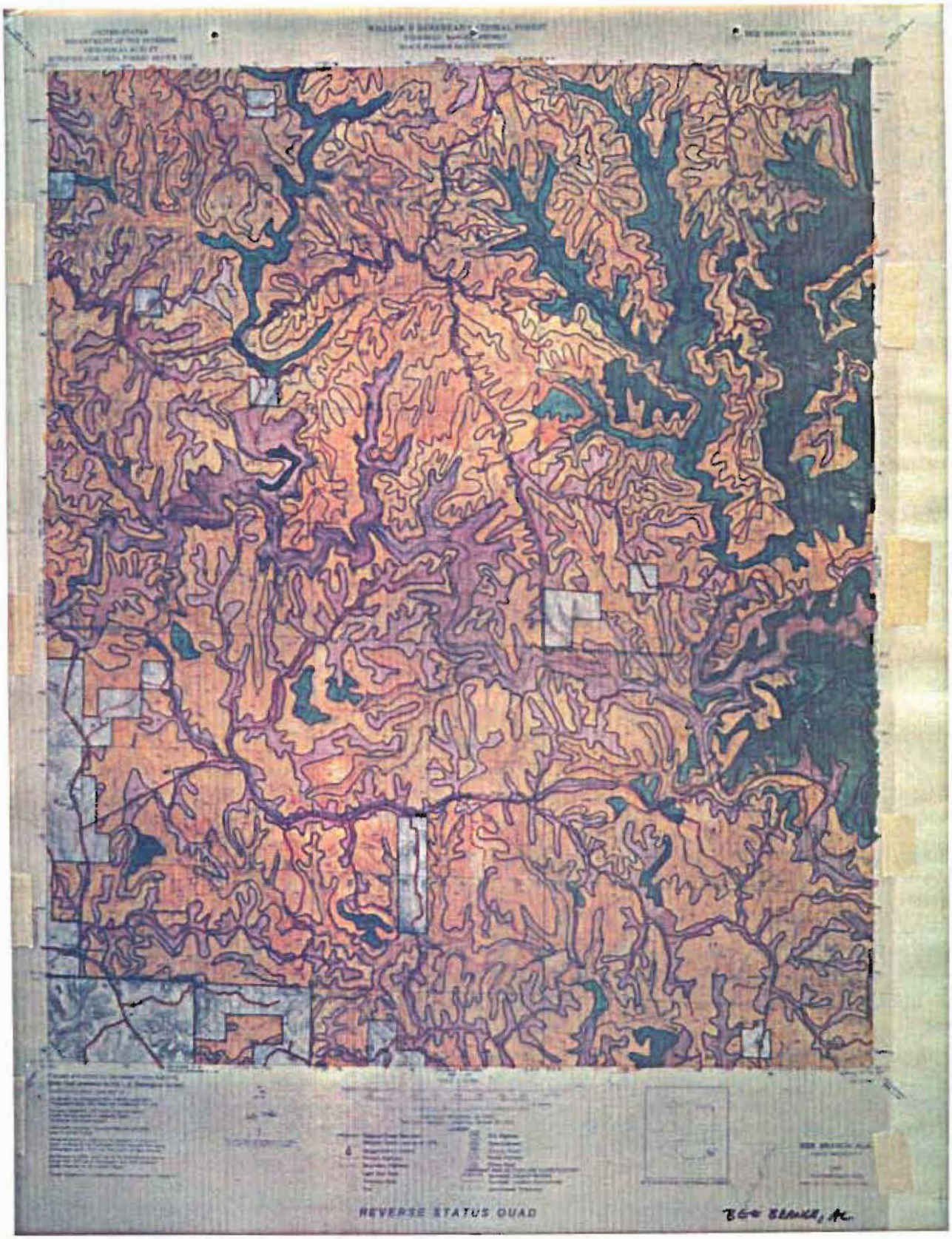

Figure 12. Annosus root rot hazard rating of Bankhead National Forest lands in the Bee Branch, Alabama, quadrangle.

Figure 13. Annosus root rot hazard rating of Bankhead National Forest lands in the Grayson, Alabama, quadrangle.

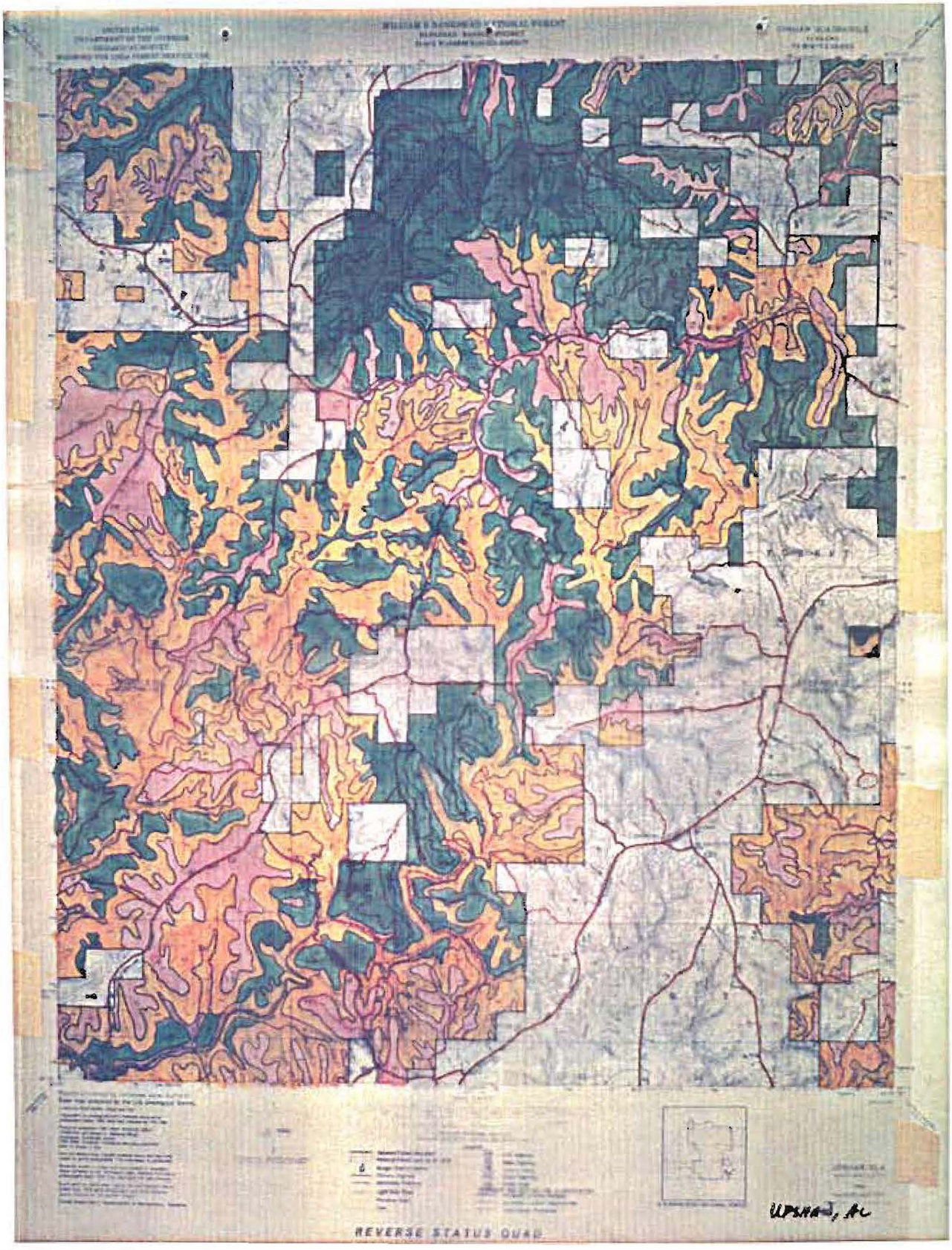

Figure 14. Annosus root rot hazard rating of Bankhead National Forest lands in the Upshaw, Alabama, quadrangle.

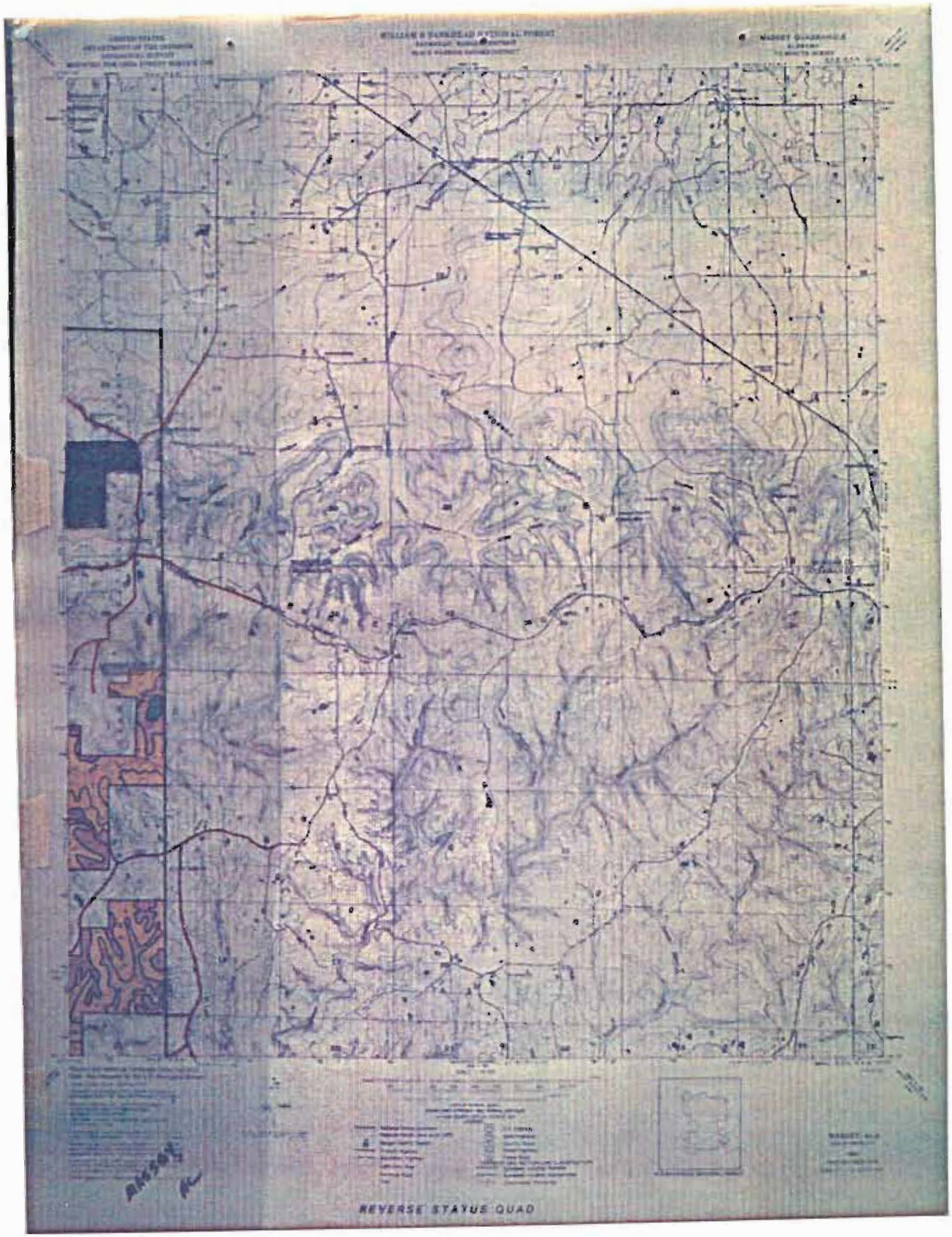

Figure 15. Annosus root rot hazard rating of Bankhead National Forest lands in the Massey, Alabama, quadrangle.

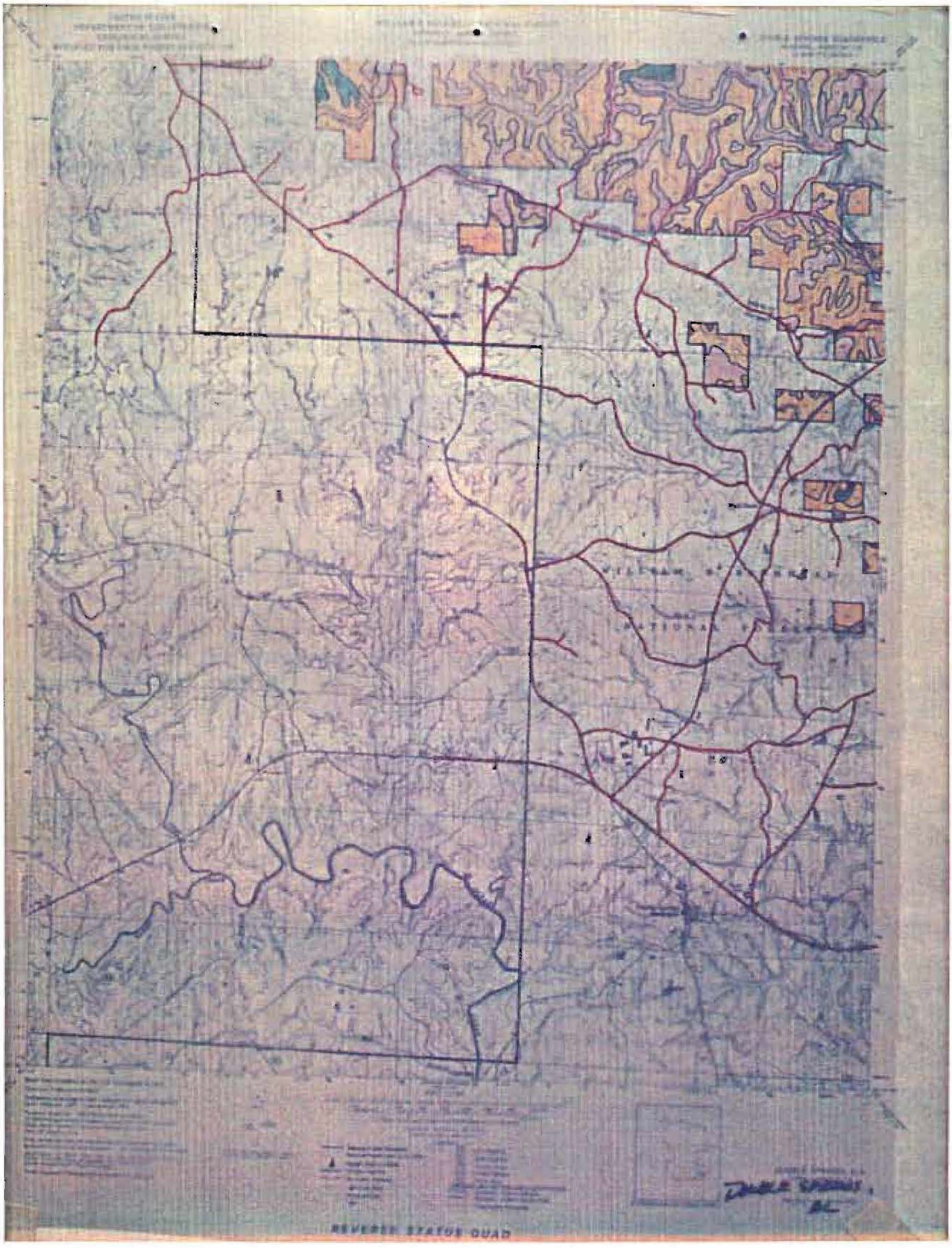

Figure 16. Annosus root rot hazard rating of Bankhead National Forest lands in the Double Springs, Alabama, quadrangle.

Figure 17. Annosus root rot hazard rating of Bankhead National Forest lands in the Houston, Alabama, quadrangle.

Figure 18. Annosus root rot hazard rating of Bankhead National Forest lands in the Addison, Alabama, quadrangle.

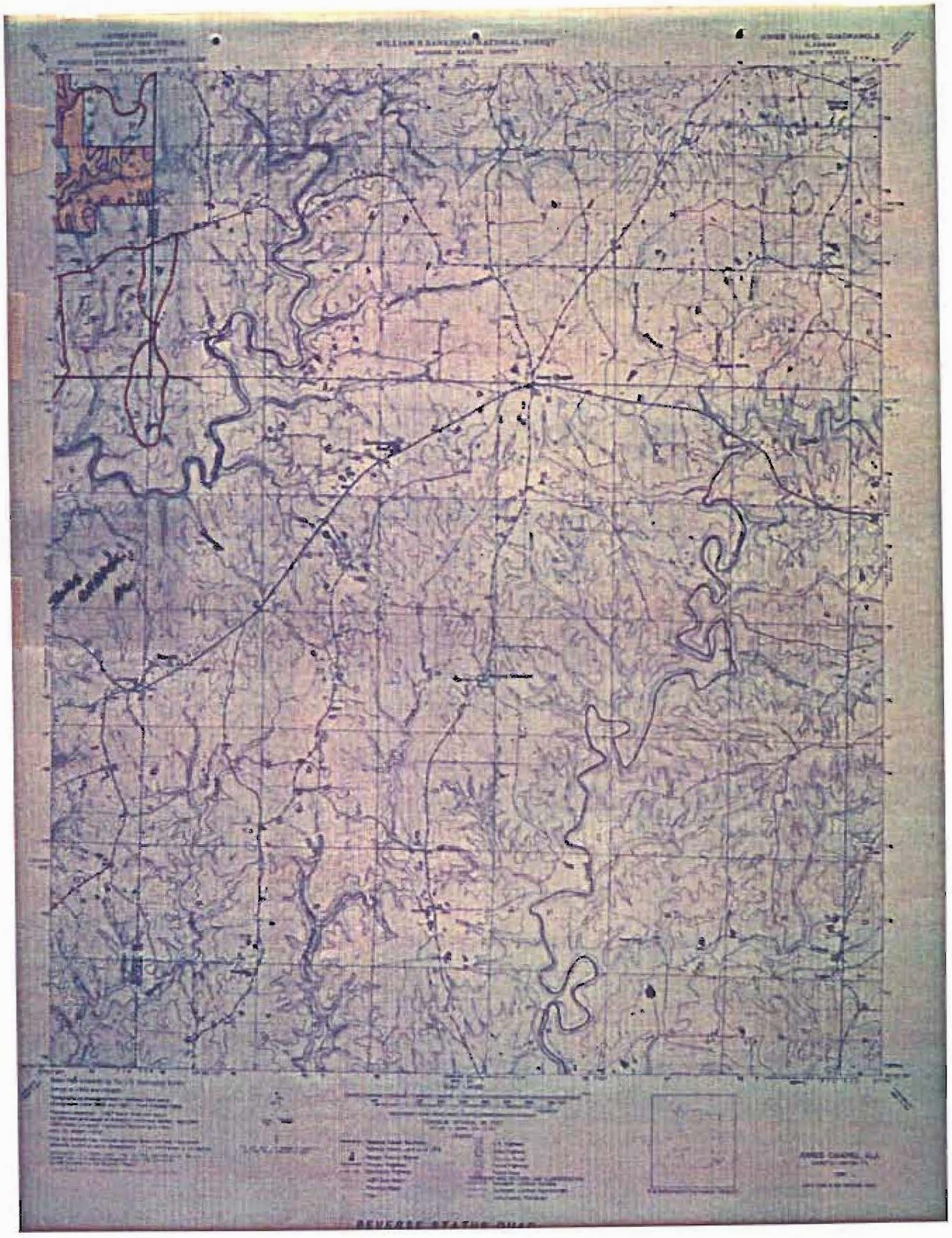

Figure 19. Annosus root rot hazard rating of Bankhead National Forest lands in the Jones Chapel, Alabama, quadrangle.

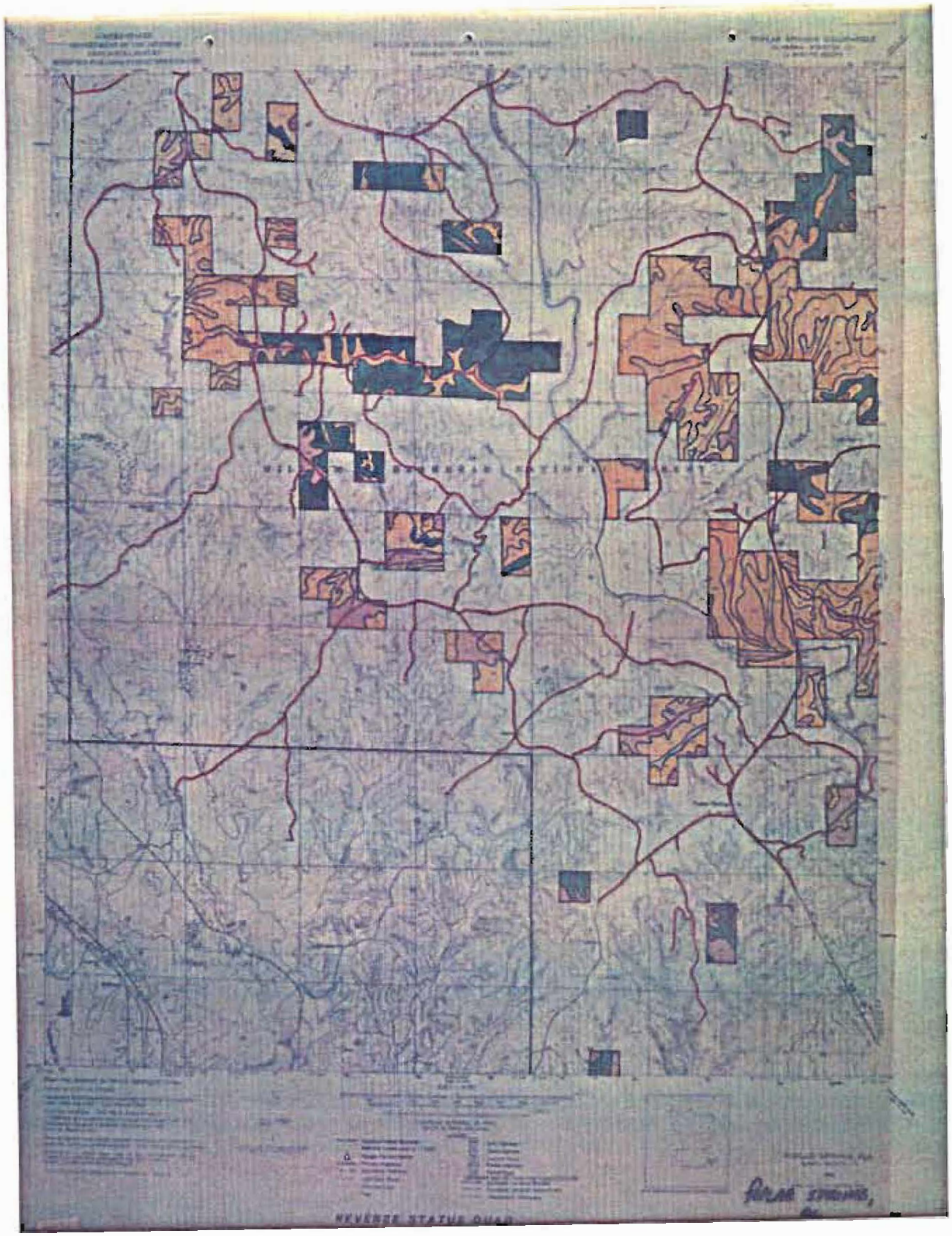

Figure 20. Annosus root rot hazard rating of Bankhead National Forest lands in the Poplar Springs, Alabama, quadrangle.

Figure 21. Annosus root rot hazard rating of Bankhead National Forest lands in the Black Pond, Alabama, quadrangle.

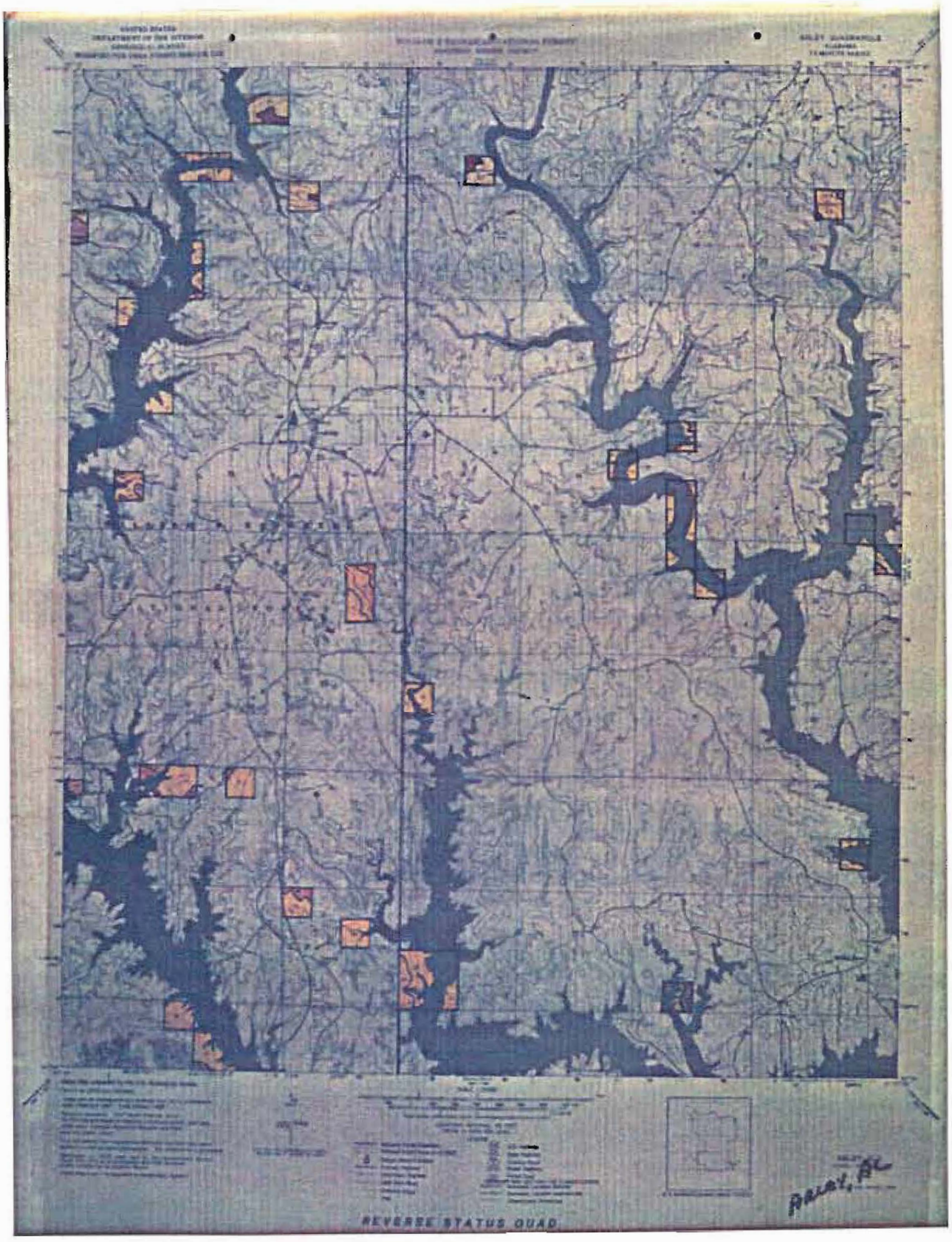

Figure 22. Annosus root rot hazard rating of Bankhead National Forest lands in the Arley, Alabama, quadrangle.

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